

# EINTHOVEN on the World Wide Web: A Tool for Analysis of Cardiac Arrhythmias

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## INTRODUCTION

The increased emphasis on primary care in the U.S. medical system has led to an increased reliance on the primary care physician for specialty care. We have previously developed a decision-support tool for ECG rhythm analysis, named the EINTHOVEN system that has been validated with clinical electrocardiograms taken from a teaching text and is still under development. The long-term goal is to support ECG interpretation by health care providers without access to cardiologists. In this paper we describe a World Wide Web (WWW) hypertext interface to EINTHOVEN that allows users to analyze cases from a library of ECG rhythm strips.

## METHODS

The Universal Resource Locator (URL) is <http://eindhoven.oukhsc.edu/>. We used the standard HTTP server software from CERN (version 3.0pre6, using libwww version 2.16beta).

Usage of the server was logged by the CERN-HTTPD server. The log file was analyzed by the **wusage** program, version 3.2 after excluding local machines and GIF files of icons.

## RESULTS

### Usefulness of the Resource

Our server became operational in November, 1994. Growth in usage has been approximately linear (see Figure 1A). We are announcing the site formally in this paper; usage to date has been due to word of mouth and by WWW search robots.

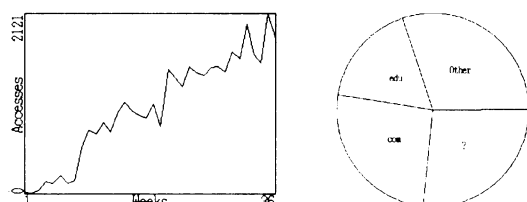


Figure 1: Server Usage

We invited users to enter their names, addresses, and comments in a log file. Of the 198 users

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who submitted their names between November 14, 1994, and August 2, 1995, 95 also submitted comments that concerned the content of this project. Most of these were either general enthusiasm or requests for new or augmented features. Unexpectedly, 25 users sent separate email to the investigators requesting help with medical questions on behalf of themselves or of family members.

The largest group of users log in from commercial machines (Figure 1B), most of which are commercial Internet providers. The "Other" category includes all users outside the USA.

## Problems Encountered

1. Limitations of Popular Operating Systems.  
Some WWW browsers for the Intel platform appear to assume that file names on remote systems will not exceed the 11 characters permitted under the DOS operating system. In addition, some WWW browsers for this platform sometimes have trouble resolving symbolic host names even though they worked correctly when the corresponding numeric IP addresses were used. A more minor issue is the limited screen size associated with popular microcomputers, especially portable computers.
2. Limitations of the HTML Paradigm.  
The major limitation of the HTML paradigm that relates to interaction with users is that each mouse click forces retrieval of a new HTML document. There is no mechanism to store a sequence of mouse clicks to be transmitted as a group, or to track the motion of the mouse.

## DISCUSSION and CONCLUSIONS

The HTML interface is sufficiently powerful to enable meaningful user interaction but is not powerful enough to allow the user to create new regions on graphical images. This capability would be required to, for example, mark the onset and offset of waves on an electrocardiogram. Other limitations are noted above.

Problems related to data security are not an issue with demonstration systems such as EINTHOVEN in its current form. We plan to extend our system to analyze ECG rhythms on identifiable patients. At that stage, it will be important to ensure confidentiality with data encryption and a secure server, as well as to ensure the medical accuracy of the analyses.

Publication of a WWW page implies the availability of expertise in the area of the page. Authors may expect to be contacted by Internet users from around the world.